Claims

1. An energy storage device comprising at least one reticulated electrode in ionic contact with an electrolyte.

2. An energy device comprising a first electrode having features defining a plurality of extensions into an electrolyte matrix.

3. The energy device of claim 2, further comprising a second electrode having features shaped to be complementary to the extensions.

4. A bipolar device comprising:

a first electrode having a first set of protuberances extending into an electrolyte; and

a second electrode having a second set of protuberances constructed and arranged to be complementary to the first set of protrusions.

5. The bipolar device of claim 4, wherein the first set of protuberances are separated from the second set of protuberances at a substantially uniform distance.

6. An electrode comprising a framework having a porous network defined therein.

7. The electrode of claim 6, wherein the porous network is ionically interconnected.

8. The electrode of claim 6, wherein the porous network has a porosity density that varies from a first end to a second end.

9. The electrode of claim 8, wherein the porosity density is at least less than 10% from an average porosity density at the first end.

10. The electrode of claim 9, wherein the porosity density is at least greater than 10 % from an average porosity density at the second end.

11. The electrode of claim 10, wherein the porosity density varies from the first end to the second end by more than about 5%.

12. A battery comprising:

a first electrode;

a second electrode;

a first current collector in electronic communication with the first electrode; and

a second current collector in electronic communication with the second electrode;

wherein the first electrode includes a portion, positioned between the first current collector and the second electrode, having a porosity that increases in a direction from the first current collector toward the second electrode.

13. A battery as in claim 12, further comprising a porous separator separating the first electrode and second electrode, the battery constructed and arranged to receive a liquid electrolyte permeating the separator and at least a portion of the porous portion of the first electrode.

14. A battery as in claim 12, wherein the first and second electrodes each include a porous portion adapted to receive a liquid electrolyte, each of the first and second electrodes having a porosity that increases in a direction toward the other electrode.

15. A battery as in claim 12, wherein the first electrode has a porous portion with an average porosity of from about 10 to about 70%.

16. A battery as in claim 12, wherein the first electrode has a porous portion with an average porosity of from about 20 to 50%.

17. A battery as in claim 12, wherein the first electrode has a porous portion with an average porosity of from about 30 to 45%.

18. A battery as in claim 12, the first electrode having a porous portion with an average porosity and a porosity gradient in a direction from the first current collector toward the second electrode, wherein the porosity at each extreme of the gradient is at least 10% different from the average porosity.

19. A battery as in claim 12, the first electrode having a porous portion with an average porosity and a porosity gradient in a direction from the first current collector toward the second electrode, wherein the porosity at each extreme of the gradient is at least 20% different from the average porosity.

20. A battery as in claim 12, the first electrode having a porous portion with an average porosity and a porosity gradient in a direction from the first current collector toward the second electrode, wherein the porosity at each extreme of the gradient is at least 30% different from the average porosity.

21. A battery as in claim 12, wherein the porosity of any cross section of the first electrode perpendicular to a line connecting the center of mass of the current collector and the center of mass of the second electrode is uniform to +/- 10%.

22. A battery as in claim 12, wherein the porosity of any cross section of the first electrode perpendicular to a line connecting the center of mass of the current collector and the center of mass of the second electrode is uniform to +/- 5%.

23. A battery as in claim 12, wherein the porosity of any cross section of the first electrode perpendicular to a line connecting the center of mass of the current collector and the center of mass of the second electrode is uniform to +/- 3%.

24. A battery as in claim 12, wherein the porosity of any cross section of the first electrode perpendicular to a line connecting the center of mass of the current collector and the center of mass of the second electrode is uniform to +/- 1%.

25. A battery as in claim 12, wherein the first electrode has a porosity gradient in a direction from the first current collector toward the second electrode having a slope that varies by no more than 5% at any location.

26. A battery as in claim 12, wherein the first electrode has a porosity gradient in a direction from the first current collector toward the second electrode having a slope that varies by no more than 10% at any location.

27. A battery as in claim 12, wherein the first electrode has a porosity gradient in a direction from the first current collector toward the second electrode having a slope that varies by no more than 15% at any location.

28. An apparatus comprising a first electrode having a first mating surface for positioning proximate an opposing electrode, the mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 1.5 times the theoretical surface area of the first mating surface in a smooth, non-reticulated configuration.

29. An apparatus as in claim 28, wherein the first mating surface has a surface area at least 2 times the theoretical area of the mating surface in a smooth, non-reticulated configuration.

30. An apparatus as in claim 28, wherein the first mating surface has a surface area at least 2.5 times the theoretical area of the mating surface in a smooth, non-reticulated configuration.

31. An apparatus as in claim 28, wherein the first mating surface has a surface area at least 3 times the theoretical area of the mating surface in a smooth, non-reticulated configuration.

32. An apparatus as in claim 28, wherein the first mating surface has a surface area at least 4 times the theoretical area of the mating surface in a smooth, non-reticulated configuration.

33. An apparatus as in claim 28, wherein the first mating surface has a surface area at least 5 times the theoretical area of the mating surface in a smooth, non-reticulated configuration.

34. An apparatus as in claim 28, wherein the protrusions have an average height of about 100% relative to their respective adjacent indentations.

35. An apparatus as in claim 28, wherein the protrusions have an average height of about 75% relative to their respective adjacent indentations.

36. An apparatus as in claim 28, wherein the protrusions have an average aspect ratio of at least about 2.

37. An apparatus as in claim 28, wherein the protrusions have an average aspect ratio of at least 2.5.

38. An apparatus as in claim 28, wherein the protrusions have an average aspect ratio of at least 3.0.

39. An apparatus as in claim 28, wherein the protrusions have an average aspect ratio of at least 4.0.

40. An apparatus as in claim 28, wherein the protrusions have an average aspect ratio of at least 5.0.

41. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 1.5 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

42. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 2 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

43. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 2.5 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

44. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 3 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

45. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 3.5 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

46. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 4 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

47. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 4.5 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

48. An apparatus as in claim 28, further comprising a second electrode having a second mating surface reticulated so as to define a plurality of protrusions and intervening indentations providing a surface area at least 5 times the theoretical surface area of the second mating surface in a smooth, non-reticulated configuration.

49. An apparatus as in claim 41, wherein the first and second mating surfaces are positioned in register such that protrusions of each mating surface are substantially aligned with indentations of the other mating surface.

50. The apparatus as in claim 41, wherein the average distance between mating surfaces is less than 100 microns.

51. The apparatus as in claim 50, wherein the average distance between mating surfaces is less than 50 microns.

52. The apparatus as in claim 50, wherein the average distance between mating surfaces is less than 25 microns.

53. The apparatus as in claim 50, wherein the average distance between mating surfaces is less than 10 microns.

54. The apparatus as in claim 50, further comprising an electrolyte positioned between the first and second mating surfaces.

55. The apparatus as in claim 54, wherein the electrolyte is solid.

56. The apparatus as in claim 54, wherein the electrolyte is liquid.

57. The apparatus as in claim 28, wherein the electrode is porous.

58. An electrode comprising a plurality of channels defined therein and constructed and arranged to allow diffusion of an ionic species from an electrolyte to a surface thereof.

59. The electrode of claim 58, wherein the channels extend substantially across the electrode.

60. The electrode of claim 58, wherein an end of each channel is in ionic communication with the electrolyte.

61. The electrode of claim 58, wherein the channels are arranged to be substantially parallel.

62. The electrode of claim 58, wherein the channels are disposed from each other at a distance that is less than a smallest dimension of the electrode.

63. A battery comprising electrode in contact with an electrolyte and having a plurality of channels defined therein and constructed and arranged to allow diffusion of an ionic species from the electrolyte to a surface thereof.

64. A battery comprising at least one perforated electrode in ionic communication with an electrolyte.

~~58.~~65 A bipolar device comprising a porous electrode that is free of polymer binder.

~~59.~~66 A bipolar device comprising a porous electrode that is free of carbon additive.

~~60.~~67 A method for facilitating providing energy comprising providing a battery comprising a first electrode, a second electrode, a first current collector in electronic communication with the first electrode and a second current collector in electronic communication with the second electrode, wherein the first electrode includes a portion, positioned between the first current collector and the second electrode, having a porosity that increases in a direction from the first current collector toward the second electrode.

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